

# Hydro 2000

G/S

## user manual





# Hydro 2000G/S User Manual

MAN0385 Issue 1.0 March 2007

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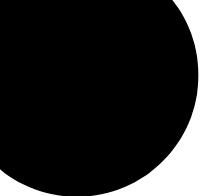
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Part 1 -

Operator's Guide





# Introduction to this manual

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## Introduction

This manual describes the operation of the large volume Hydro 2000G and small volume Hydro 2000S sample dispersion units:

Instrument	Model number
Hydro 2000G	AWA2000
Hydro 2000S	AWA2001

This manual is a supplement to the following manuals:

- **Mastersizer 2000 User Manual** (termed “the main **User Manual**”).
- **Mastersizer 2000 Essentials Manual** (termed “the **Essentials Manual**”).

This dispersion unit manual focuses on some specific issues of the dispersion unit that are not covered by the above manuals. It aims to:

- Describe what the dispersion unit is and explain in simple terms how it works.
- Identify the physical features of the dispersion unit.
- Describe the software and explain how to use the dispersion unit to make a measurement on the system.



### Warning!

The dispersion unit or the samples to be measured may be hazardous if misused. Users must read the **Health and Safety** information in the **Essentials Manual** before operating the system.

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We recommend that users who have never operated a Malvern particle analyser before read this manual fully before starting the first measurement.

Those who are more familiar with particle size analysers may wish to jump straight to **Chapter 4** of the main **User Manual** which gives details on making measurements. However, the importance of sample preparation before measurement cannot be overstated so we recommend reading the chapter on sample preparation (**Chapter 8** of the main **User Manual**) as a priority.

## Access to the instrument

Within this manual, reference is made to the various people who will have access to the dispersion unit. Below is a list of these people and their responsibilities:

### Malvern personnel

Malvern personnel (service engineers, representatives, etc.) have full access to the dispersion unit and are authorised to perform all service procedures that may require the removal of the covers.

### Supervisor

The supervisor is the person responsible for the management/safety of the dispersion unit and of its operation. The supervisor is responsible for the training of the operators. The supervisor can perform all user maintenance routines identified in **Chapter 4** of the **Essentials Manual**, including changing the fuses.



#### Warning!

The supervisor/operator must never remove the covers of the instrument or dispersion unit. Removal of the covers by unauthorised personnel will invalidate the warranty of the dispersion unit.

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### Operator

An operator is a person trained in the use of the dispersion unit. The operator can perform all user maintenance routines identified in **Chapter 4** of the **Essentials Manual**, except for changing the fuses.



#### Warning!

Failure to follow this guideline could result in exposure to hazardous voltages.

---

# Assumed information

All pictures and text show the Hydro 2000G unless information is specific to the Hydro 2000S.

## Naming convention

Within this manual:

- The Mastersizer 2000 optical bench is referred to as “the optical bench” or “the instrument”.
- The sample dispersion units are referred to in full (e.g. “the Hydro 2000G”) or as “the dispersion unit”.
- The combination of the optical bench, one or more dispersion units and the computer is referred to as “the system”.

## Menu commands

Menu commands from the Malvern software are referred to in the form **main menu-menu item**. As an example, the command **Configure-New SOP** refers to selecting the **New SOP** item in the **Configure** menu. The same rules apply for sub-menus of sub-menus, so that **Tools-Options-Instrument Port** refers to the **Instrument Port** item in the **Options** sub-menu, which itself is a sub-menu of the **Tools** menu. Menu commands are always shown in bold text.

# Where to get help

Full details on where and how to obtain help can be found in **Chapter 1** of the main **User Manual**.

The **Essentials Manual** gives information on the following:

- Site requirements.
- Health and Safety.
- Maintenance.
- Installation (in case the system has to be moved after its initial installation by Malvern Instruments personnel).



# Hardware features

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## Introduction

This chapter describes the physical features of the dispersion unit. It covers:

- What the dispersion unit does.
- How the dispersion unit works.
- How the dispersion unit is controlled.
- The physical features of the Hydro 2000G in detail.
- The physical features of the Hydro 2000S in detail.

## What the dispersion unit does

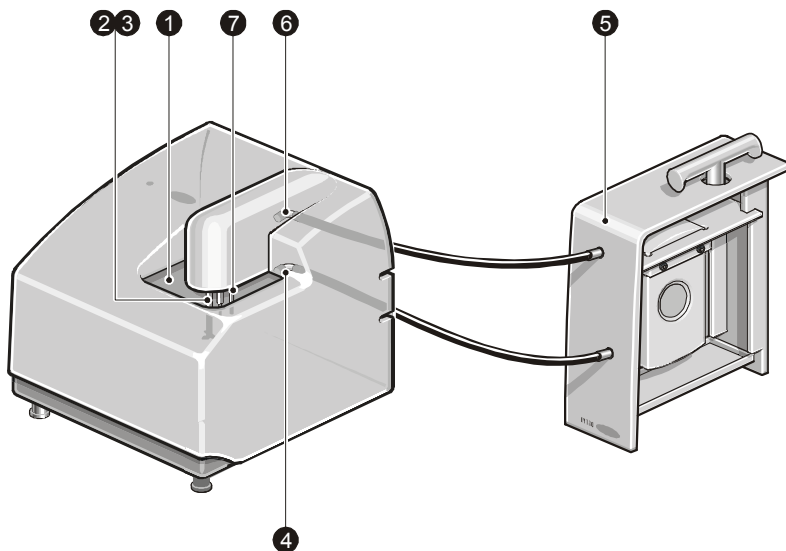
The sole purpose of any sample dispersion unit is to prepare the sample and then deliver it to the optical bench so that it can be measured.

The Hydro 2000G and Hydro 2000S allow the Mastersizer to be used for particle-in-liquid particle sizing. Functionally, the two dispersion units are virtually identical except that the Hydro 2000G can circulate 800ml of liquid while the Hydro 2000S has a smaller capacity of 150ml. The small volume of the Hydro 2000S is ideal when using solvent dispersants or when samples and dispersants are either expensive or hazardous.

The materials used in the manufacture of the dispersion units maximise the range of samples which can be handled. Variable pump/stirrer speeds allow a wide range of particle sizes and densities to be suspended and circulated, whilst a variable power ultrasonic system enables particle agglomerates to be dispersed.

## How the dispersion unit works

This is the Hydro 2000G:



ill 4911

The dispersion unit comprises a tank ① that holds one litre of sample/dispersant liquid. A stirrer ②, controlled from the software, agitates the sample and stops it from settling or separating out. The pump ③, controlled from the software, forces the sample from the TO CELL port ④ of the dispersion unit to the flow cell ⑤ located in the optical bench, via the sample tubing. The pump and stirrer can be independently controlled.

The sample is pumped through the flow cell and then returns to the tank via the sample tubing and the FROM CELL port ⑥.

An ultrasonic probe ⑦ is provided to aid sample dispersion and can also be used to remove bubbles from the flow path.

The dispersion unit contains two fluid handling valves controlled from the software:

- A motor-driven drain valve that allows the tank to be drained.
- A dispersant valve that opens to allow clean dispersant into the tank.

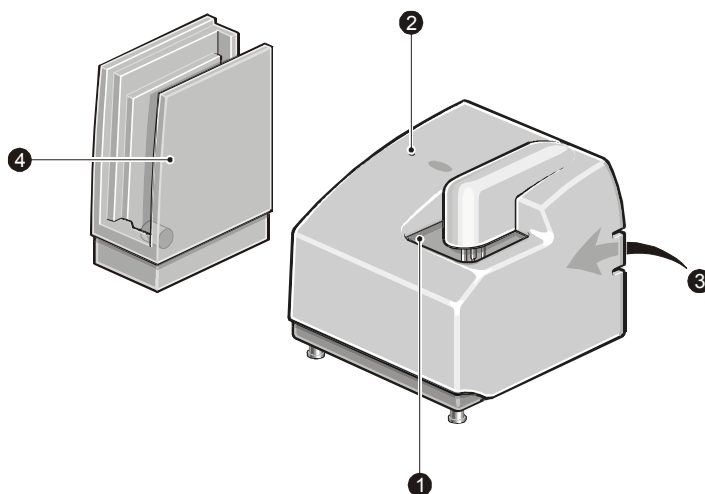
The operation of the Hydro 2000S is virtually identical, except that it has a combined pump/stirrer mechanism and a smaller (150ml) tank capacity.

## How the dispersion unit is controlled

The dispersion unit is controlled using a single software dialogue with sliders for the pump speed, stirrer speed and ultrasonic power (**Chapter 3** has details). When controlled through a Standard Operating Procedure (SOP), the software tells the user what value to set for each parameter.

## Features of the Hydro 2000G

This illustration identifies the main features of the dispersion unit:



ill 4912

These are the following:

### ① Tank area

The tank holds the sample and dispersant. The pump and stirrer in the tank keep the sample in suspension and continually circulate the sample and dispersant through the flow cell. More details on the tank area are given below.

An ultrasonic probe also helps to disperse the sample. All functions of the tank area are controlled by the Malvern software.

### ② Status indicator

The status indicator illuminates in one of three colours when the dispersion unit is powered up:

- **green** if the dispersion unit is functioning correctly and its cell **has** been loaded into the optical bench. (i.e. the dispersion unit is “active”)

- **amber** if the dispersion unit is functioning correctly but its cell **has not** been loaded into the optical bench. (i.e. the dispersion unit is at “standby”)
- **red** if the dispersion unit detects an error. If an error message does not appear on the screen, selecting **Configure-Accessory** displays the accessory control dialogue which should show the error.

### ③ Rear panel

The rear panel contains all services and communication connectors for the dispersion unit. More details on the rear panel are given later in this chapter.

### ④ Cell holder

The Mastersizer 2000 system is designed so that more than one dispersion unit can be connected at once. The cell holder provides a convenient storage location for the flow cell if another dispersion unit is in use.

The cell holder reduces the build up of dust on the cell windows when not in use.

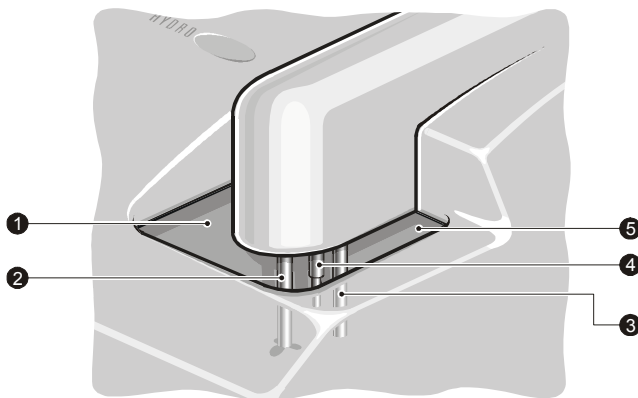
If the cell is not used for short periods (up to 24 hours), leave the cell and tank full of clean dispersant so that the cell windows do not dry out, leaving smears or water marks on the window surface.

If the push on connectors are to be removed, the cell may be stored wet by using the syringe supplied to fill it with clean dispersant.

If the cell is not to be used for longer periods, remove and dry the cell windows; the **Essentials Manual** has details. The cell holder houses the window removing tool in its base.

## Tank area

As described above, the tank holds the sample and dispersant. The pump and stirrer in the tank keep the sample in suspension and continually circulate the sample and dispersant through the cell. This diagram identifies the features of the tank area:



ill 4914



These are the following:

① Tank

The tank can hold up to one litre of sample and dispersant for circulation through the cell of the optical bench.



**Warning!**

Due to the possible risk of sonication of the blood and its unknown effects, never place fingers in the tank when the ultrasonic probe is in operation. Also, never put fingers in the tank when the pump/stirrer shaft is rotating.

---

Sample and dispersant can be poured directly into the tank. If this is done, do not cause the tank to overflow by filling it too quickly. Clean any spillage off the covers immediately to prevent damage.

② Pump/stirrer

The stirrer, located in the base of the tank, agitates the sample/dispersant mixture. The pump circulates the sample through the flow cell located in the sample area of the optical bench. The pump and stirrer speeds are controlled independently by the software.



**Warning!**

Never put fingers into the tank when the pump/stirrer shaft is rotating.

---



**Caution!**

Never operate the pump/stirrer at more than half speed with the tank empty.

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③ Ultrasonic probe



**Warning!**

Due to the possible risk of sonication of the blood and its unknown effects, never put fingers in the tank when the ultrasonic probe is in operation.

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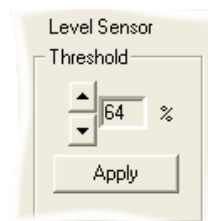
The ultrasonic probe is used to help disperse samples. The power of the probe is controlled through the software.

④ Level sensor

The level sensor automatically stops the tank being filled above a certain level. If the tank fails to fill properly then the level sensor may require cleaning or the

threshold settings may need adjusting. The **Essentials Manual** has more details on cleaning the level sensor.

The level sensor must be set to detect different types of dispersant by setting the level sensor threshold. This is done by selecting **Configure-Accessories**. The **Level Sensor Threshold** section is shown below:



Use the up and down arrows to set the threshold for the dispersant used then click the **Apply** button. The values of commonly used dispersants are listed below:

Water (default)	64%
White spirit	36%
Propan-2-ol	64%
2-2-4 Trimethyl pentane	36%

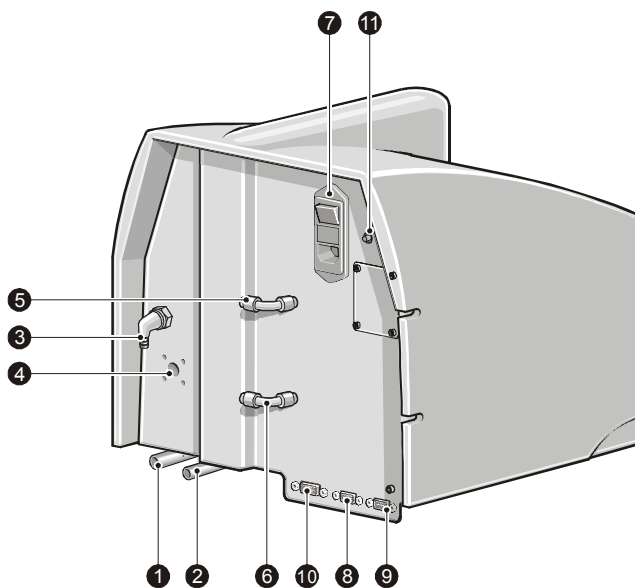
The level sensor threshold must always be set when a different dispersant is used. Level sensor thresholds are also stored in the dispersant database.

#### ⑤ Tank cover

The tank cover is there to protect the operator from splashes from the tank. Always replace the cover after adding sample to the tank.

## Rear panel

This illustration identifies the main features of the rear panel:



ill 4913

These are the following:

### ① Drain

The drain port is the exit point where sample/dispersant leaves the dispersion unit. A warning triangle warns that the contents of the tank are drained from this pipe. The risk depends on the hazardous nature of the dispersants/samples being measured.

The drain pipe should not exceed 2m in length, must run downwards and should have no loops or kinks.

### ② Dispersant input port

The dispersant input is the inlet port which is connected to a clean source of dispersant. A warning triangle warns that the dispersant may be hazardous, though for most applications it will be water.

### ③ Air purge inlet

If using a particularly aggressive dispersant, this may cause the grease in the pump motor bearings to leach out. If this may be a problem, the air purge inlet port can be used to connect an air supply. This will keep fumes away from the bearings. The air supply must be maintained at all times when aggressive dispersants are used;

**Appendix A** gives the purge air supply specifications.

④ Tank fill rate

This adjuster alters an internal pressure regulator that will control the rate at which the tank is filled with dispersant. This is always set by the installation engineer but if it's found that the dispersant pressure has changed (one sign is that the tank takes a long time to fill), alter this adjuster so that a fill tank cycle takes about 20 seconds.

⑤ “From cell” pipe

This is the sample return port where the sample/dispersant returns to the dispersion unit from the flow cell in the optical bench.

⑥ “To cell” pipe

This is the sample-out port where sample/dispersant leaves the dispersion unit for the flow cell.

⑦ Mains power supply

The mains power supply is a standard IEC socket that supplies mains power to the dispersion unit. It also houses the dispersion unit's fuses and its on/off switch.

⑧ Accessory comms “in” connector

The communications cable from the optical bench or from another dispersion unit connects here.

⑨ Accessory comms “out” connector

If more than one dispersion unit is connected to the system and this is the first dispersion unit in-line then a communication cable will be connected from this connector to the **accessory comms - “in”** connector of the second dispersion unit.

The termination plug supplied with the optical bench **must** be fitted here if this is the only dispersion unit connected or it is the last dispersion unit in the line.

⑩ Auxiliary connector

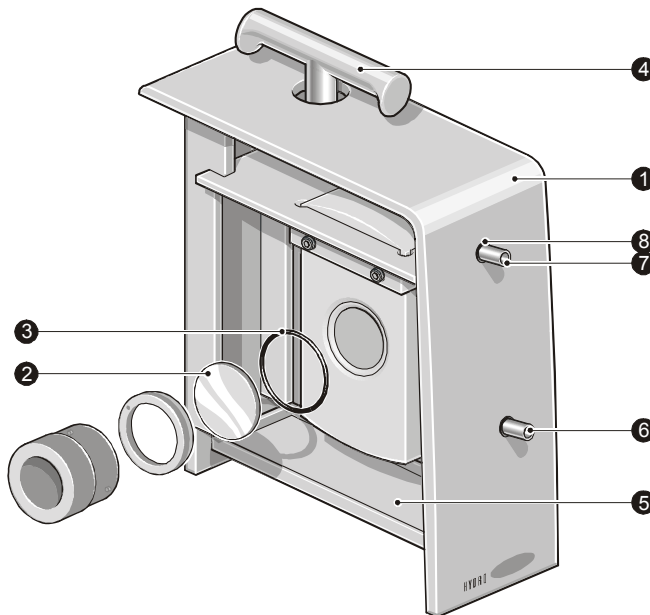
Not used.

⑪ Manual drain

The manual drain button can be pressed to drain the tank (the dispersion unit must be powered up first). Users may wish to do this if, for example, they need to drain the dispersion unit without having to turn on the control software. Pressing and holding the button will open the drain valve. Releasing the button will close the drain valve.

## Flow cell

The flow cells for the Hydro 2000S and Hydro 2000G are identical except for internal identification encoding and the label badge. This diagram shows the cell:



The flow cell passes the sample/dispersant through the analyser beam of the optical bench so that it can be measured. The cell windows are part of the optical path of the system and must be kept clean and free from scratches at all times. The **Essentials Manual** gives details on cleaning/maintaining the cell.



### Caution!

The flow cell is an optical device. Treat it as carefully as an expensive camera. Scratches to the surfaces of the cell may affect performance.

Each cell is encoded so that as soon as it is loaded into the optical bench, the system will detect and identify it.

The cell features are:

#### ① Cell shroud

The cell shroud prevents stray light entering the measurement area that may affect a measurement. More importantly, the cell shroud stops human access to laser radiation. **Never use the system if the cell shroud is damaged.**

### ② Cell windows

The cell windows allow the analyser beam of the optical bench to pass through the cell and hence the particle field. The cell windows can be removed to allow cleaning (the cell window tool used to remove the window is located within the cell holder). The cell windows are delicate and should be treated with caution; refer to the **Essentials Manual** for details on cleaning them.

### ③ Cell window seals

The cell window seals prevent the windows from leaking. Inspect them regularly, especially if using aggressive solvents as a dispersant. Details on changing the cell window seals can be found in the **Essentials Manual**.

### ④ Locking handle

The cell locking handle must be rotated anti-clockwise to lock the cell in place on the optical bench. To remove the cell, rotate the handle clockwise and lift the cell clear.



### Warning!

Never try to lift the optical bench by its locking handle. The **Health and Safety** section (**Essentials Manual**) gives correct moving techniques.

---

### ⑤ Drip tray

Any small leaks will be captured within the drip tray and drained through a drain port in the base of the optical bench. If any liquid is noticed in the drip tray, remove the cell and tip the contents away. Locate and fix any leaks.

### ⑥ “Cell in” connector

The sample tube from the dispersion unit is connected here. It is important that the sample flows up through the cell so any bubbles in the flow path can escape.

### ⑦ “Cell out” connector

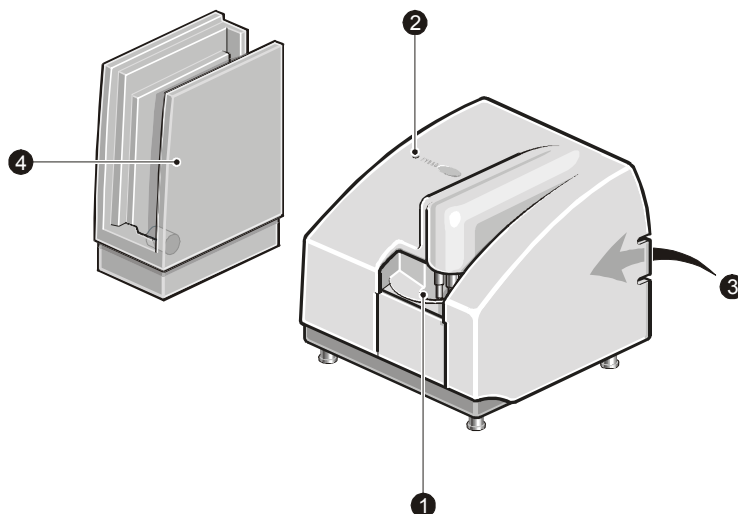
The sample return pipe from the cell to the dispersion unit is connected here.

### ⑧ Pipe grommets

The pipe grommets prevent light entering the measurement area. These must be replaced if they are damaged in any way.

# Features of the Hydro 2000S

This illustration identifies the main features of the dispersion unit:



ill 4916

## ① Tank area

The tank holds the sample and dispersant. A combined pump/stirrer within the tank keeps the sample in suspension and continually circulates the sample and dispersant through the flow cell. More details on the tank area are given below.

An ultrasonic probe also helps to disperse the sample. All functions of the tank area are controlled by the Malvern software.

## ② Status indicator

The status indicator illuminates in one of three colours at power up:

- **Green** if the dispersion unit is functioning correctly and its cell **has** been loaded into the optical bench. (i.e. the dispersion unit is “active”).
- **Amber** if the dispersion unit is functioning correctly but its cell **has not** been loaded into the optical bench. (i.e. the dispersion unit is at “standby”).
- **Red** if the dispersion unit has detected an error. If an error message does not appear on the screen, selecting **Configure-Accessory** will display the accessory control dialogue which should show the error.

## ③ Rear panel

The rear panel contains all services and communication connectors for the dispersion unit. The rear panel is described in detail below.

#### ④ Cell holder

The Mastersizer system is designed so that more than one dispersion unit can be connected at once. The cell holder provides a convenient storage location for the flow cell if another dispersion unit is in use.

The cell holder reduces the build up of dust on the cell windows when not in use.

If the cell is not used for short periods (up to 24 hours), leave the cell and tank full of clean dispersant so that the cell windows do not dry out, leaving smears or water marks on the window surface.

If the push on connectors are to be removed, the cell may be stored wet by using the syringe supplied to fill it with clean dispersant.

If the cell is not to be used for longer periods, remove and dry the cell windows; refer to the **Essentials Manual** for details. The cell holder houses the window removing tool in its base.

## Tank area

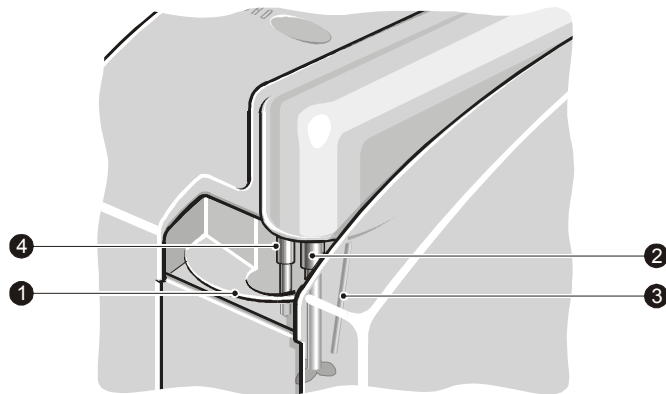
As described above, the tank holds the sample and dispersant. The pump/stirrer in the tank keeps the sample in suspension and continually circulates the sample and dispersant through the cell.



### Warning!

Due to the possible risk of sonication of the blood and its unknown effects, never put fingers in the tank when the ultrasonic probe is in operation. Also never put fingers into the tank when the pump/stirrer shaft is rotating.

This diagram identifies the features of the tank area:



ill 4918



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### ① Tank

The tank can hold up to 150ml of sample and dispersant for circulation through the cell of the optical bench.

Sample and dispersant can be directly poured into the tank. If doing so, do not overflow the tank by filling it too quickly. **Do not tip a sample onto the lip of the tank as fine particles may settle out and bias the measurement.**

### ② Pump/stirrer

The stirrer, located in the base of the tank, agitates the sample/dispersant mixture in the tank. The pump circulates the sample through the flow cell. The pump and stirrer speeds are controlled independently through the software.



#### Warning!

Never put fingers in the tank when the pump/stirrer shaft is rotating.

---



#### Caution!

Never operate the pump/stirrer at more than half speed with the tank empty.

---

### ③ Ultrasonic probe

The ultrasonic probe is used to help disperse samples. Its power is controlled through the software.



#### Warning!

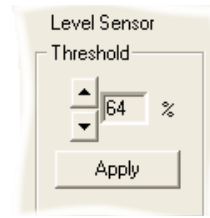
Due to the possible risk of sonication of the blood and its unknown effects, never put fingers in the tank when the ultrasonic probe is in operation.

---

### ④ Level sensor

The level sensor automatically stops the tank being filled beyond a certain level. If the tank fails to fill properly the level sensor may require cleaning or the threshold settings may need adjusting. The **Essentials Manual** shows how to clean the level sensor.

The level sensor must be set to detect different types of dispersant by setting the level sensor threshold. This is done by selecting **Configure-Accessories**. The **Level Sensor Threshold** section is shown below:



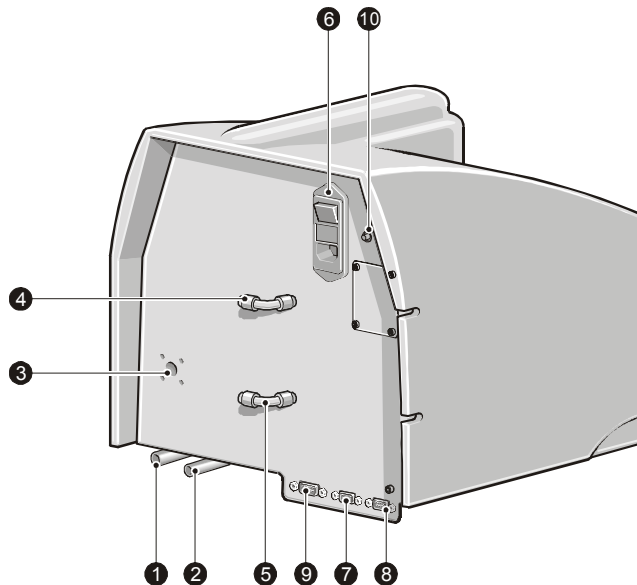
Use the up and down arrows to set the threshold for the dispersant then click the **Apply** button. The values of some commonly used dispersants are listed below.

- Water (default) - 64%
- White spirit - 36%
- Propan-2-ol - 64%
- 2-2-4 Trimethyl pentane - 36%

The level sensor threshold must always be set when a different dispersant is used. Level sensor thresholds are also stored in the dispersant database.

## Rear panel

This illustration identifies the main features of the rear panel:



### ① Drain and overflow

The drain and overflow port is the exit point where sample/dispersant leaves the dispersion unit. A warning triangle warns that the contents of the tank are drained

ill 4917

from this pipe. The risk depends on the hazardous nature of the dispersants and samples being measured.

The drain pipe should not exceed 2m in length and should have no loops or kinks.

#### ② Dispersant input port

The dispersant input is the inlet port which is connected to a clean source of dispersant. A warning triangle warns that the dispersant may be hazardous, though for most applications it will be water.

#### ③ Tank fill rate

This adjuster alters an internal pressure regulator that controls the rate at which the tank is filled with dispersant. This is always set by the installation engineer but if it's found that the dispersant pressure has changed (one sign is that the tank takes a long time to fill), alter this adjuster so that a fill tank cycle takes about six seconds.

#### ④ “From cell” pipe

This is the sample return port where the sample/dispersant returns to the dispersion unit from the flow cell in the optical bench.

#### ⑤ “To cell” pipe

This is the sample out port where sample/dispersant leaves the dispersion unit for the flow cell.

#### ⑥ Mains power supply

The mains power supply is a standard IEC socket that supplies mains power to the dispersion unit. It also houses the dispersion unit's fuses and its on/off switch.

#### ⑦ Accessory comms “in” connector

The communications cable from the optical bench or from another dispersion unit connects here.

#### ⑧ Accessory comms “out” connector

If more than one dispersion unit is connected to the system and this is the first dispersion unit in line then a communication cable will be connected from this connector to the **accessory comms “in”** connector of the second dispersion unit.

The termination plug supplied with the optical bench must be fitted here if this is the only dispersion unit connected or it is the last dispersion unit in the line.

#### ⑨ Auxiliary connector

This is not used.

#### ⑩ Manual drain

The manual drain button can be pressed to drain the tank. Users may wish to do this if, for example, they need to drain the dispersion unit without having to turn on the control software. Pressing and holding the button will open the drain valve. Releasing the button will close the drain valve.

## Hydro 2000S flow cell

The flow cells for the Hydro 2000S and Hydro 2000G are identical except for internal identification encoding and the label badge.

Refer to the **Flow Cell** section for the Hydro 2000G above to identify the features of the cell.

# Software features

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## Introduction

This chapter describes the features of the software which are specific to the dispersion unit. It covers:

- Making a measurement – the basics of making a measurement using the dispersion unit.
- Manually controlling the dispersion unit.
- Writing a Standard Operating Procedure (SOP) for the dispersion unit.
- Advanced software – the vari-flow facility.

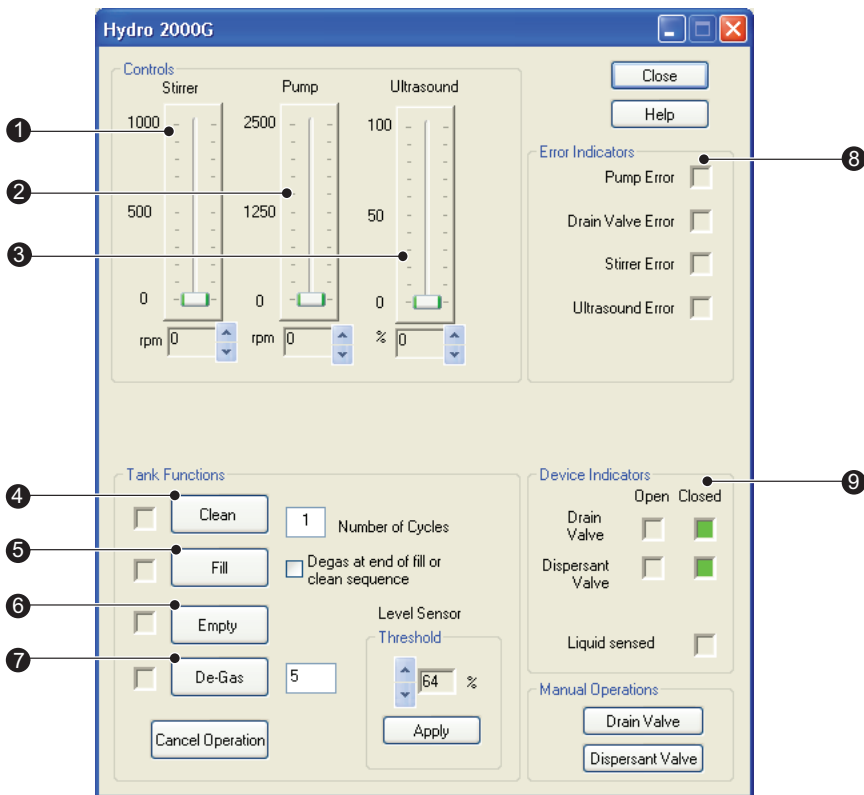
## Making a measurement

Making a measurement using the Hydro 2000S and Hydro 2000G is fully documented in **Chapter 4** of the **Mastersizer 2000 User Manual**. Refer to that manual for details.

The dispersion unit can either be controlled manually or automatically by running an SOP. The system automatically detects which dispersion unit and cell is connected. If more than one dispersion unit is connected, the system detects all dispersion units connected, but only the dispersion unit that has its cell installed on the optical bench will be “active”.

## Manually controlling the dispersion unit

To control the dispersion unit manually, either select **Configure-Accessory** or, when making a manual measurement, click the **Accessory** button in the **Measurement Display** window. The accessory control dialogue shown below appears:



The contents of this dialogue change depending on the dispersion unit connected. It allows the user to alter the pump speed, stirrer speed and ultrasonic power by moving the relevant **Controls** slider bar.

This dialogue also allows the user to fill and drain the tank by pressing the relevant **Tank Functions** buttons. Status indicators give information such as whether the drain valve is open/closed, and whether the level sensor has been triggered (the tank is full), as well as reporting any errors within the dispersion unit.

The features change depending on which dispersion unit is connected, but are:

### ① Stirrer control

The speed of the stirrer is altered by moving the slider. Use the up and down arrows under the slider for fine adjustment of the stirrer speed.

**Note**

For the Hydro 2000S the **Pump** and **Stirrer** slide bars are combined into a single slider.

**② Pump control**

The speed of the pump is altered by moving the slider. Use the up and down arrows under the slider for fine adjustment of the pump speed.

**③ Ultrasound control**

The power of the ultrasonic probe is altered by moving the slider. Use the up and down arrows under the slider for fine adjustment of the ultrasonic power.

**④ Tank cleaning**

Pressing the **Clean** button enables a clean sequence.

If the sample/dispersant in use is not normally removed with a single flush, enter a number in the **Number of Cycles** box to cycle through the flush sequence this number of times.

**⑤ Tank filling**

Pressing the **Fill** button opens the dispersant valve and fill the tank. The dispersant valve automatically closes when the level sensor detects liquid. Selecting the **Degas at end of fill/clean sequence** check box enables the Degas facility outlined in ⑦ below after the tank has filled.

**⑥ Tank emptying**

Pressing the **Empty** button opens the drain valve and empty the tank. The **Manual Drain** button on the rear panel of the dispersion unit has the same function.

**⑦ Degassing**

Degassing helps to remove dissolved gasses and bubbles from the dispersant. Pressing the **De-Gas** button pulses the ultrasonic probe for the amount of time specified in the adjacent seconds box.

**⑧ Error indicators**

The following indicators illuminate if an error condition is detected:

- **Pump Error** – illuminates if the pump fails to reach the requested speed. As an example this may be due to the sample/dispersant being particularly viscous.
- **Drain Valve Error** – illuminates if the drain valve has failed to drive (i.e. it is stuck open or closed.). This may be caused by leaving a sample in the tank for long periods; this may set and bond the drain valve.

**Caution!**

Never leave sample in the tank for long periods - always flush the tank and leave it filled with clean dispersant. Contact the Malvern representative if the **Drain Valve Error** indicator illuminates.

---

- **Stirrer Error** – illuminates if the stirrer fails to reach the requested speed. Again, this may be due to the sample/dispersant being particularly viscous.
- **Ultrasonics Error** – illuminates if the ultrasonics fail to reach the requested power. Contact the Malvern representative for assistance.

**⑨ Device indicators**

The device indicators give the status of the drain and dispersant valves:

- Drain Valve open – tank empties.
- Drain Valve closed – tank remains full.
- Dispersant Valve open - tank fills with dispersant.
- Dispersant Valve closed - tank stops filling with dispersant.

The **Liquid sensed** indicator illuminates if the level sensor detects dispersant i.e. the tank is full. If this indicator illuminates but the tank is still empty, the level sensor may need cleaning; see **Chapter 4** of the **Essentials Manual**.



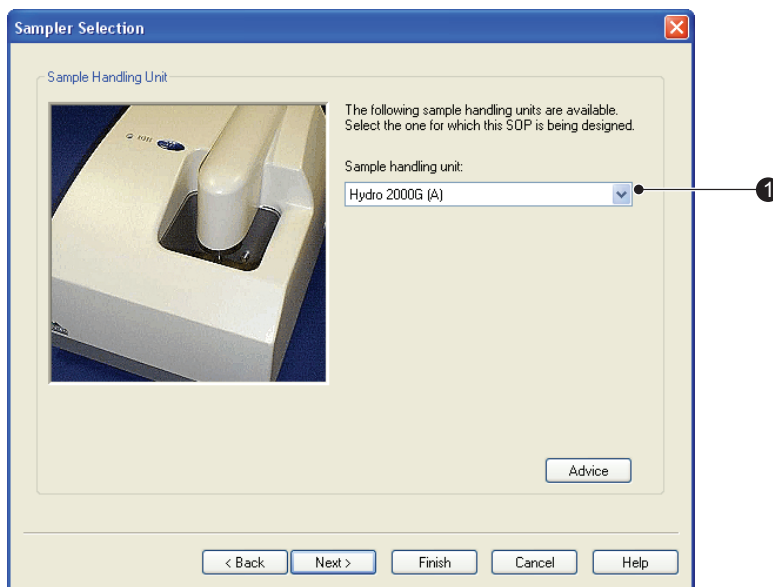
## Writing an SOP for the dispersion unit

An SOP can be configured to control all settings for the dispersion unit automatically. When an SOP is run, the software will (depending on how the SOP has been set up) automatically fill the tank, flush the tank to clean it, run a de-gas routine to remove bubbles from the dispersant and then set the pump, stirrer and ultrasound to predefined settings. The SOP will even report if the wrong cell or dispersion unit is fitted.

The **SOP Wizard** is described in full in the main **User Manual**. There are ten dialogues in all but here we just describe those which have parameters specific to the Hydro 2000G/S. These are the **Sampler Selection** and **Sampler Settings** dialogues.

### Sampler Selection dialogue

The **Sampler Selection** dialogue is shown below:



Select the dispersion unit to be used from the drop down list ①. All dispersion units available will be listed, even those that are not attached to the system. This enables an SOP to be written remotely from the system.

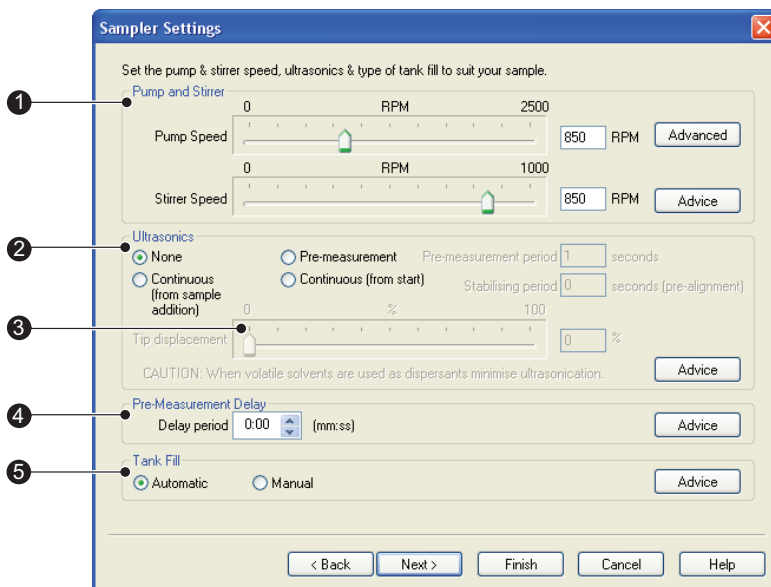
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The system allows up to two of each dispersion unit to be connected to the optical bench. In this situation, the dispersion units will be identified as unit A and B - for example, there might be an entry for Hydro 2000G (A) and Hydro 2000G (B). If using just one dispersion unit, select the "A" option.

All systems the SOP is distributed to must have the dispersion unit connected.

## Sampler Settings dialogue

The **Sampler Settings** dialogue controls the pump, stirrer and ultrasonic settings for the dispersion unit. This dialogue changes depending on the dispersion unit selected in the **Sampler Selection** dialogue. This is the dialogue for the Hydro 2000G:



Its components are:

### ① Pump and stirrer settings

The speed of the pump and stirrer is altered by moving the relevant slider. This tab will show a single control for the pump/stirrer if the Hydro 2000S is selected in the **Sampler selection** dialogue. The **Advanced** button allows the vari-flow options to be set; these are described below.

### ② Ultrasonics selection

The ultrasonics selection radio buttons enable the ultrasonics. The options are:

- **None** – no ultrasound.
- **Continuous (from sample addition)** – ultrasound is activated after sample is added and will run continuously.
- **Pre-measurement** – activates ultrasound for a set time before measurement. Type the required duration in seconds in the **Pre-measurement period** box.

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- **Continuous (from start)** – ultrasound is active throughout the measurement. Ultrasound will start after the electrical background is complete. The stabilising period will add a delay between the electrical background and the optical alignment. During this delay ultrasound will be operating, allowing bubbles to be driven from the dispersant.

### ③ Tip displacement slider

The tip displacement sets the power of the ultrasonics. Moving the slider to 100% gives full power ultrasonic dispersion.

### ④ Pre-Measurement Delay

A pre-measurement delay can be added before the measurement to allow thermal equilibration to occur after ultrasound has been applied. If this is not done the analysis may show the presence of large particles which are not in the sample. This is caused by the refractive index differences observed in the sample cell when the dispersant is not equilibrated. Choose a delay sufficiently long enough for adequate thermal equilibration to occur.

To set the delay, highlight either the minutes or seconds in the **Delay period** box, then use the selection arrows to alter the time; alternatively the time can be typed in. A delay of between **0** and **59.59** minutes can be chosen.

### ⑤ Tank Fill options

The user can fill the tank with dispersant manually or automatically. For the tank to be filled automatically, the dispersant must be plumbed into the dispersant inlet port on the rear panel; a solenoid valve then controls the flow into the tank.

If, however, a solvent is to be used as a dispersant, it is unlikely that this will be plumbed into the dispersion unit. Here select **Manual**. This switches off the solenoid valve and the tank can be filled by hand. (This means that, if the unit is connected to a water supply, the dispersant inlet does not have to be disconnected during a manual fill). The software states when to fill the tank during an SOP measurement.

## Advanced software features: Vari-flow

Some materials, such as metal flakes, may form structures when they are circulated through the flow cell at normal pump speeds. These structures cause a secondary diffraction pattern that is incorrectly interpreted as a small peak at 1000 microns.

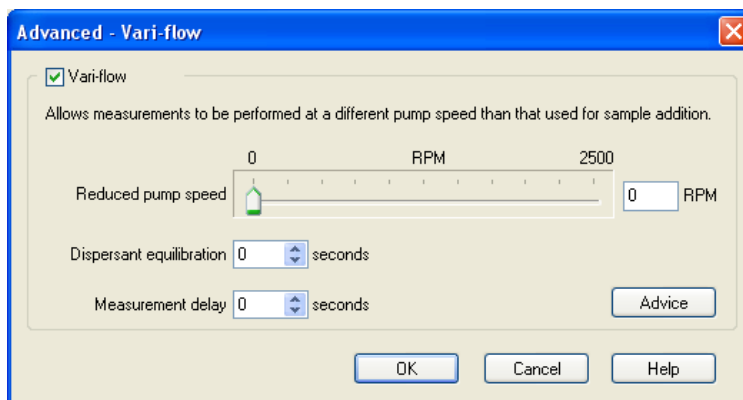
Vari-flow (accessed by selecting the **Advanced** button in the **Sampler Settings** dialogue) allows these materials to be dispersed in the tank in the normal way. The pump is then briefly turned off or its speed reduced before measurement of the sample. When the pump is turned off, the structures in the sample are randomised and the measurement can be made without the occurrence of the secondary diffraction pattern.

When the flake material is suspended in a volatile solvent such as white spirit, vari-flow is even more useful since it assists the rapid thermal stabilisation of the dispersant. When the sample tank is filled with fresh solvent, very high backgrounds are often observed. These arise from thermal gradients in the solvent causing steering of the laser beam onto the inner rings of the detector array. As the temperature equilibrates, the background falls to normal levels (80-100) and measurement can proceed. Pausing the pump after the solvent has had a chance to thoroughly disperse through the system will accelerate the fall of the background to normal levels.

### What is the sequence of events?

The Vari-flow cycle is as follows:

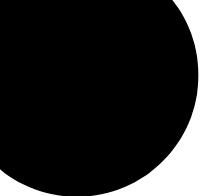
1. The pump is operated at normal speed (set in the SOP) for an initial period to allow the dispersant to be thoroughly mixed and become thermally homogeneous. This initial period, the **Dispersant equilibration period**, can be set in this dialogue:



2. The pump speed falls to a predetermined reduced level (**Reduced pump speed** in the dialogue - this can be zero) and an additional **Measurement delay** allows the background level to fall before the alignment is performed and the background measured. (This “Optical equilibration period” is the same as the measurement delay).
3. The pump speed is returned to the higher rate for the sample to be added and dispersed in the normal way.
4. Before the measurement stage is entered, the pump speed drops to the lower level and the system waits for the duration of the **Measurement delay** before measuring the sample. This delay allows the relaxation of the sample in the flow cell so that a normal measurement can be obtained.
5. If repeat measurements are required the pump will return to the high level for a brief re-dispersion period (the **Measurement delay**), then drop down again for the measurement process to be repeated. This will continue for as long as prescribed in the SOP.



# Part 2 - Appendices





# Specification

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## Hydro 2000G

<b>Dispersion type</b>	Wet
<b>Capacity</b>	1 litre
<b>Typical applications</b>	Minerals, fillers, chemicals, foodstuffs, emulsions
<b>Dispersion mechanisms</b>	Continuously variable and independent pump, stirrer and ultrasonics.
<b>Modes of operation</b>	Automatic via SOPs. Manual via computer operating dialogues.
<b>Weight</b>	18.7kg
<b>Dimensions</b>	Width: 348mm Height: 333mm Depth: 365mm
<b>Power</b>	100-120V / 200/240 V AC, 50/60Hz, 240VA
<b>Maximum size of particles</b>	Up to 2000 microns, depending on particle shape and density.

## Hydro 2000S

<b>Dispersion type</b>	Wet
<b>Capacity</b>	50-150ml
<b>Typical applications</b>	Solvent-based suspensions, Pharmaceuticals.
<b>Dispersion mechanisms</b>	Continuously variable combined pump/stirrer. Continuously variable ultrasonics
<b>Modes of operation</b>	Automatic via SOPs. Manual via computer operating dialogues.
<b>Weight</b>	16.8kg
<b>Dimensions</b>	Width: 348mm Height: 333mm Depth: 365mm
<b>Power</b>	100-120V / 200/240 V AC, 50/60Hz, 240VA
<b>Maximum size of particles</b>	Up to 600 microns, depending on particle shape and density.

## Purge air specification (Hydro 2000G)

This section only applies to the Hydro 2000G.

If a particularly aggressive dispersant is used, this may cause the grease in the pump motor bearings to leach out. If this may be a problem the air purge inlet port can be used to connect an air supply. This will keep fumes away from the bearings.

If required to use the air purge inlet connector (see **Chapter 2**), check that the air supply conforms to the following specification:

- 1800ml air/min at 212mbar g.
- 0.064 cu ft/min at 3.0psi g.
- Filtered to remove all particles larger than 0.5 microns (if the dispersion unit is to be used in unclean environments).

# Chemical compatibility

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## Introduction

The Hydro 2000G and Hydro 2000S are manufactured from materials that give the widest protection from chemical attack. However, it is important to check that any sample or dispersant used is chemically compatible with the materials that they will come into contact with within the dispersion unit.

This appendix lists all materials that come into contact with the sample and dispersant in normal operation.

## Components in contact with sample/dispersant

Component	Materials
Tank and pump cavity	316 stainless steel, Viton
Internal pipes	316 stainless steel and F.E.P.
Level sensor	P.E.E.K.
Pump/stirrer	316 stainless steel and P.T.F.E.
Ultrasonic probe	Titanium
Drain valve	316 stainless steel, P.T.F.E, Perlast™ and Viton
Sample pipes to cell	Tygon™
Drain pipe	PVC
Cell	Glass, 316 stainless steel, Viton
Splash guard (Hydro 2000G only)	Acrylic



### Note

For the Hydro 2000S Viton seals can be upgraded to Perlast™ to improve the chemical compatibility. Contact the Malvern representative for details.



# Regulatory statements

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This section presents the CE Declarations of Conformity for the products.

# CE Declaration of Conformity (AWA2000)

The CE badge on this product signifies conformance to European Commission Directives.

## CE Declaration of Conformity



(In accordance with ISO/IEC 17050-1)  
Date: 15.02.2007  
Issue: 0001

Form: 0734F CE Declaration of Conformity

### Supplier details

Document (NAME / NUMBER)

CE declaration of conformity for AWA2000 (2007).doc

Issuer's Address (ADDRESS OF MANUFACTURER)

Enigma Business Park,  
Grovewood Road,  
Malvern,  
Worcestershire, WR14 1XZ, UK

Issuer's Name (NAME OF MANUFACTURER)

Malvern Instruments Limited

### Product details

Product description – name and model number(s)

Name : Hydro 2000G

Model : AWA2000

Description : Particle Dispersion Unit

Directive(s) and Standard(s) to which conformity is declared

EMC directive 89/336/EEC as amended by 92/31/EEC and 93/68/EEC  
Low Voltage Directive 2006/95/EC

BS EN 50081-2 : 1994

BS EN 50082-2 : 1995

BS EN 61000-3-2 : 1995 CLASS A

BS EN 61000-3-3 : 1995

BS EN 61010-1: 2001 and part 2 as required

### Additional Information

### Declaration

I hereby declare that the product specified conforms with the provisions of Council Directive(s) and standard(s) listed above.

Signed for and the behalf of Malvern Instruments Limited.

Place of issue

Malvern Instruments Limited (UK)

Signature

Date of issue

14/03/2007

Name (Function)

Alan Bragginton (Production Director)

# CE Declaration of Conformity (AWA2001)

The CE badge on this product signifies conformance to European Commission Directives.

## CE Declaration of Conformity



(in accordance with ISO/IEC 17050-1)  
Date: 15.02.2007  
Issue: 0001

Form: 0734F CE Declaration of Conformity

### Supplier details

Document (NAME / NUMBER)

CE declaration of conformity for AWA2001 (2007).doc

Issuer's Name (NAME OF MANUFACTURER)

Malvern Instruments Limited

Issuer's Address (ADDRESS OF MANUFACTURER)

Enigma Business Park,  
Grovewood Road,  
Malvern,  
Worcestershire, WR14 1XZ, UK

### Product details

Product description – name and model number(s)

Name : Hydro 2000S

Model : AWA2001

Description : Particle Dispersion Unit

Directive(s) and Standard(s) to which conformity is declared

EMC directive 89/336/EEC as amended by 92/31/EEC and 93/68/EEC  
Low Voltage Directive 2006/95/EC

BS EN 50081-2 : 1994  
BS EN 50082-2 : 1995  
BS EN 61000-3-2 : 1995 CLASS A  
BS EN 61000-3-3 : 1995  
BS EN 61010-1: 2001 and part 2 as required

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Signed for and the behalf of Malvern Instruments Limited.

Place of issue

Malvern Instruments Limited (UK)

Signature

A handwritten signature in black ink, appearing to read "Alan Bragginton".

Date of issue

14/03/2007

Name (Function)

Alan Bragginton (Production Director)





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